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stance, is a matter of inference rather than of observation, are we sure that we have a better guarantee for it than a previous century had for phlogiston? Our good opinion of ourselves, as compared with our scientific fathers, makes us think we have. I think myself that we have; and yet, remember, it is the same human nature which judged that evidence then, that judges this evidence now, and remember that however rapidly science changes human nature remains very much the same, and always has a good conceit of itself.

While we are venturing to utter truisms, I repeat, let us take once more this one, home to ourselves, that there is a great deal of this 'human nature' even in the best type of the scientific man, and that we of this twentieth century share it with our predecessors, on whom we look pityingly, as our successors will look on us.

Let us repeat, and repeat once more, that though nature be external to ourselves, the so-called 'laws of nature' are from within—laws of our own minds—and a simple product of our human nature. Let us agree that the scientific imagination can suggest questions to put to nature, but not her answers. Let us read Bacon again, and agree with him that we understand only what we have observed. Finally let us add that we never understand even that, in the fullness of its meaning, for remember that of all the so-called laws of nature the most constantly observed and most intimately and personally known to us, are those of life and death—and how much do we know about the meaning of *them*?

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#### KINETIC EVOLUTION IN MAN.

IN a recent number of *SCIENCE* Mr. W J McGee has summarized his reasons for holding that anthropological evolution is a process of integration standing in direct

contrast to the divergence of biological evolution:

"The great fact attested by all observation on human development, and susceptible of verification in every province and people, is that mankind is not differentiating in either physical or psychical aspects, but are converging, integrating, blending, unifying, both as organisms and as superorganic groups.

"Everywhere the developmental lines converge forward and diverge backward, just as the lines of biotic development diverge forward and converge backward. How this discrepancy is to be removed is a question whose importance increases with every advance in the science of anthropology."\*

That human evolution is synthetic appears undeniable, but the discrepancy pointed out by Mr. McGee has been removed in advance by the recognition of the same leading principle in biological evolution. Man is better known than any other animal, and evolutionary theories which do not accommodate this best certified series of biological facts might well have been distrusted. The kinetic factor of synthesis has been neglected because biologists as well as anthropologists have failed to perceive that evolutionary progress is a cause instead of a result of the differentiation of species or varieties, but since evolution must be studied in species an adequate comprehension of the evolutionary phenomena of any specific group should make plain their relation to more general principles.

Isolation and segregation favor constancy in the characters by which systematists are accustomed to distinguish species, but it is as erroneous with other animals as with man to infer from this that isolation conduces to evolutionary

\* 'Current Questions in Anthropology,' *SCIENCE*, N. S., Vol. 14, No. 365, pp. 996 and 997.

progress. The truth lies rather with the contrary proposition, since the unknown causes of variation also predispose to the perpetuation, communication and accumulation of organic, physiologic and other tendencies of change. Some variations or mutations are of little evolutionary significance and must be segregated in order to be preserved, but others are notably prepotent and are accepted by a large proportion of the individuals of successive generations. Reproductive accessibility to prepotent variations is the measure of evolutionary progress. Species confined to small areas are often distinct from each other by characters of no diagnostic significance among related forms of wide distribution. The latter appear plastic and flexible because they have access to many avenues of biological motion, while the former maintain a relatively narrow and stable uniformity because the few genetic variations are soon distributed through the small number of individuals.

Evolution may be termed a kinetic\* process because change is not only a potential but an essential of organic existence. Static theories have sought to explain organic changes as the results of external influences; dynamic theories imply the organic predetermination of such changes; only under a kinetic theory may we admit that the changes of biological evolution have not been caused by external conditions nor by internal mechanisms, but are the manifestations of a form of motion the nature and efficient causes of which are even farther beyond the present range of our comprehension than those of the motions which underlie the phenomena of physics and chemistry.

However striking their results in particular instances, natural and other forms of selection represent the incidents rather

than the causes of evolution, and instead of being called forth and carried forward only by external forces, the gradual accentuation of characters of no direct importance or utility commonly accompanies increasing organic efficiency. Thus it has been found that varietal divergences from the specific mean of the human skull are correlated with increased intellectual power, as represented by greater cerebral bulk.

"In a brachycephalic race the rounder the skull the greater the capacity, in a dolichocephalic race the narrower the skull the greater the capacity—the greater capacity following the emphasis of the racial character."\*

Equally indifferent functionally and selectively are most of the characters of skin, hair, bones and other physical features used by anthropologists in classifying mankind, and in speculating upon the origins of the various ethnic groups. Closely analogous differences are found everywhere among the species and varieties of mammals, and they require no special explanation unless it be to place them among the many indications that the varieties of primitive man had fewer facilities of transportation and more definite geographical localization than their modern representatives. Had such segregation become complete all the requirements for the differentiation of species would have been met, and modern zoologists could make no serious or consistent objection to the treatment of the Tasmanians, Australians, Andamanese, Papuans, Ainus† and similarly isolated groups as species, no matter how insignificant a fraction of

\* Alice Lee in *SCIENCE*, N. S., Vol. 12, No. 312, p. 948.

† I am indebted to Dr. Leonhard Stejneger for the suggestion of racial affinity between the Papuans and Ainus. Dr. Stejneger holds also that the domestic and social economy of the Ainus indicates tropical origin.

\* 'A Kinetic Theory of Evolution,' *SCIENCE*, N. S., Vol. 13, June 21, 1901, p. 969.

the genus *Homo* they may include. On the other hand it seems preferable to admit that these islanders are but outliers of the larger curl-haired specific complex which covered the Old World before the arrival of the coarse-haired, smooth-skinned American species of mankind. On the continents strictly isolated groups have seldom existed for long periods, although the separation of remote peoples has been sufficient to permit the accumulation of diverse habits and characteristics which in less active, intelligent and resourceful animals would have resulted in disintegration into many segregated species.

A kinetic theory of evolution permits us to recognize the fact that with man, as in other lines of descent, there have been both differentiation and integration, and these not at separate times, but simultaneously and universally.\* Moreover, we gain a standpoint from which many formal propositions like monogenesis and polygenesis appear unnecessary for the exposition of evolutionary facts. From the standpoint of biological evolution it is about equally improbable that any given species has descended from one or two parents as that it has been compounded from distinct lines of descent. Mr. Keane, who is cited by Mr. McGee as a polygenist, is fond of discussing what he calls 'precursors' but he apparently holds still to the traditional supposition that different races originated in Central Asia and subsequently spread themselves to the various quarters of the globe, a proposition obviously contrary to all pertinent analogies of general biology.

\* That divergence as well as convergence has occurred even in the historic period is well shown by such examples as the colonists of Virginia and Massachusetts who though they had formed part of the same community in England developed on independent lines in America until they were incorporated into another social and political organization. The South African Boers might also be compared with the Dutch colonists of New York.

We are not told why one neighborhood should have given rise to so much diversity, nor why the newly formed races did not fuse at once into one homogeneous complex and thus save the ethnologists much speculation.

Few discussions of the evolution of man are without one or more of the following assumptions:

1. That man originated at some particular locality.
2. That he became differentiated into three or more distinct races or varieties.
3. The commingling of these formed the numerous peoples of the earth whose origins and pedigrees are to be inferred by resolving their characteristics into those of the component racial types, much as the artist analyzes his colors or the chemist his compounds.

Monogenists and polygenists are about equally partial to these unproved and improbable opinions, and as their differences are matters of formal terms and definitions the opportunities for scholastic controversy are excellent. At some sufficiently remote time there was a species of limited distribution which included the direct progenitor of man, but was this interesting creature man or ape? And did it differentiate into races of men or merely into varieties of apes or 'precursors' which became human independently and then hybridized to form the complex now called man? These questions can be debated indefinitely by the well-known expedient of varying the definitions which shall determine when the animals became men in the modern sense and were no longer 'old time people,' as the natives of Liberia call the chimpanzees.

But since no other animal or plant has the wide distribution of man, we may well suppose that this was attained after he had far surpassed all related species in intelligence and resourcefulness, and further

that the same qualities and tendencies which gave him this extensive range have prevented complete isolation, except in the presence of physical barriers. Polygenesis ascribes these unique powers to several apes in spite of the fact that with the exception of man, all existing species of the order Primates are animals of very limited distribution.

The doctrine of polygenesis marks a natural reaction from that of a too narrow monogenesis, but in its extreme extension attains an equal absurdity. Moreover, the term itself is unfortunate in implying many distinct centers or lines of descent which would but multiply the difficulties. The logical and biologically defensible antithesis of monogenesis is not polygenesis but eurygenesis, or the predication of a wide and largely decentralized distribution of primitive man or his precursors, if the term be preferred. Strictly speaking, man might be monogenetic and still originate all over the world by the gradual amelioration of a cosmopolitan species; and polygenesis by requiring two or more separate derivations or ameliorations, is on the biological plane an assumption inconsistent with that of an evolution by convergence and integration which would be retarded rather than advanced by the implied isolation.

Exponents of both monogenesis and polygenesis apparently neglect also the obvious fact that man's origin and primary distribution are zoological rather than ethnological questions, since an indefinitely great period of time must have elapsed between the organic perfection of man and the development of the races, languages, customs and arts studied by anthropologists. But even on zoological and geological grounds the question of origin is still in the balance, and as competent an anthropologist as Sir William Flower frankly admits that 'it is quite as likely

that the people of Asia may have been derived from America as the reverse.'\*

Not even the fact that all of man's quadrumanous relatives were confined to the Old World is conclusive. Indeed, it is strange that under static theories of evolution it was not argued that man must have originated in America, on the ground that he would not have attained his human characteristics while exposed to intermixture with his more backward simian relatives. And in further support of such a view it might have been observed that the curled hair which characterizes the peoples deemed most primitive in the Old World is apparently a specialization, the higher apes having straight hair. Likewise the small cerebral bulk of even the most advanced of the aborigines of America does not indicate descent from larger brained Old World stock.

In accordance with the evidence of tradition, history and general biology we may ascribe the convergence and integration of customs, languages and races to the intercommunication which is at once a cause and a result of human progress toward civilization. No one race or nation has had a monopoly of improvement and discovery and those which continue to progress generally obtain more from others than they originate themselves. Specialization and isolation which resist change are as clearly misfortunes to nations as to plants and animals. Within historic times the physical and intellectual powers of the race are not known to have increased, but the synthesis of skill and knowledge has continued with accelerated rapidity. Modern nations pride themselves on their adaptability, and no longer emulate the changelessness of the Medes and Persians and the Chinese.

That the nations of the earth are of one blood does not mean that they were ever of

\* *Journ. Anthropol. Inst. Gt. Britain*, 14: 391. London, 1885.

one language or one system of customs and arts, in the origination of which the doctrine of polygenesis has a wide application, since history and daily experience show that new linguistic, industrial and artistic elements originate in definite places and often with single individuals. The use of tools and weapons gave man the advantage over his fellow-creatures, and progress has been mirrored in the diversification and improvement of these servants ever since the time when all men used the unspecialized celt which the reminiscent native of Liberia still holds in his hand in leisure moments to give him that most enjoyable sensation of weight and importance. Modifications and inventions are constantly being made; use is necessarily local and hence divergent at first, but with modern facilities of communication may extend in a few years through regions which formerly would not have been penetrated in as many generations.

Civilization itself is at once a test and a testimony of the attraction exerted by new characters, powers and specializations, and of the momentum with which the motion due to such attractions may increase. Primitive and conservative are ethnological synonyms, and with races, as with individuals, it is ever the strongest and the most intelligent which are susceptible to the new idea or invention. The constant succession of modes and fashions is perhaps the most obvious example of the inherent human tendency to the new, and motion on this line is also conspicuously more rapid in our complex and utilitarian civilization than among primitive peoples. Human progress has not advanced by a uniform rate of motion; the facts of ethnology and history indicate the probability that it took more centuries to introduce the use of fire than it has required years to popularize electricity.

Somewhere intermediate between the zoological monogenesis of man's body and the ethnologic polygenesis of nations, languages and arts, there was what may be termed a biologic coordination of man and his supporting environment which placed him definitely upon the line of social and industrial progress. As long as man was content to rely upon natural products his existence was precarious and left no traces in organic nature, but in passing from the feral to the domestic state he interfered in the evolution of other species and thus gave biological clues for the location of this focus of anthropological interest. The cultivated plants were in use long before the integrations which formed present peoples, languages and arts, and thus afford far more weighty testimony on racial origins and affinities.

The Egyptian and Chaldean civilizations mark the eastern horizon of human history, but from the evolutionary standpoint they appear separated from us by but a narrow foreground. Our belief in their primal antiquity is but a reflection of traditions chronologically ancient, though biologically recent, and affording no valid opposition to the evidence that the oldest domestic plants were not natives of the Old World, but of the New, where the scarcity of nourishing fruits encouraged the use and simple cultivation of starch-producing roots, which before the domestication of cereals became the basis of a permanent food-supply and of social, industrial and cultural progress, impossible among wandering hunters and shepherds.

It has seemed reasonable to seek the origin of civilization among the most capable peoples, but, on the other hand, it should be remembered that great natural abilities have not produced civilizations except under favorable conditions. In Roman times the Teutonic peoples had not advanced much beyond the economic status of sav-

ages, and yet with brief opportunity they were able to adopt and even to improve upon the ancient cultures of the Mediterranean countries. Civilization is not an inherent but merely a potential character, more easily lost than gained, and in its earlier stages readily influenced by facts and conditions as truly biological as those which have conduced to the upbuilding of the even more specialized organization of the social ants and termites.

On this ground we may also disregard the opinion general among ethnologists and historians that the pastoral stage with which the civilization of the Mediterranean region was supposed to have begun was merged gradually and spontaneously into the agricultural. Primitive pastoral tribes are everywhere more or less nomadic, and pastoral prosperity does not conduce to a more settled existence, but makes necessary a wider range of feeding grounds, so that we should need to imagine the semi-savage shepherd planting and fencing plots of millet, barley or beans with the intention of experimenting upon new vegetable foods. But such an idea is so absurdly inconsistent with the instinctive conservatism of man's food habits that we can but believe that the pastoral natives of the Mediterranean region built civilizations only when brought into synthesis with other peoples who had made independent progress on agricultural lines.

Predatory, nomadic and pastoral peoples may develop excellent physical and mental powers, but the primary condition for the genesis of civilization is the settled social organization of an agricultural community. That agricultural habits of life conduce to civilization even among relatively inferior tribes is well shown in the numerous centers of ancient primitive culture developed in the tropics of the American continent. Ethnologists have decided that all this diversity of incipient civiliza-

tions was truly indigenous and not imported, as formerly suspected on the ground of many racial and cultural resemblances with the peoples of eastern Asia. This opinion is further supported by the biological fact that of the many plants cultivated in ancient America only the banana appears to be exotic, and this probably arrived not many centuries before the coming of Europeans.

The American origin of agricultural man in no way conflicts with an Old World origin for zoological and geological man, though these questions are often confused by ethnological writers. Such cultural tendencies as may have existed in the Mediterranean region before the arrival of agricultural influences from America appear to have been confined to the domestication of animals as the basis of a diet largely carnivorous. The aborigines of the island of Palma in the Canary group had four domestic animals and no domestic plants. The predication of independent agricultural beginnings in the Old World is rendered unnecessary by two facts long well known though strangely neglected; first, that the tropics of the Old World from Hawaii and Easter Island to Madagascar and Sierra Leone were overrun by a single primitive, agricultural, seafaring race; and, second, that this race was in possession of numerous cultivated plants of American origin. To infer from these facts that the Polynesians, Malays or Chinese came from America would be to ignore the probability that the trans-Pacific migration of this primitive culture race took place long anterior to the formation of existing peoples and languages. The identity of the tropical cultivated plants, several of which are propagated only by cuttings, renders gratuitous all objections on the score of distances and difficulties of communication, and the racial and cultural similarities of the peoples

of the two shores of the Pacific render their community of origin antecedently probable. Ethnologists have demonstrated the indigenous character of American man, but the coarse-haired yellow and brown races of Asia are evidently intruders who have replaced or amalgamated with older curl-haired peoples. While it is not impossible that some elements of the Mongoloid series may have entered Asia from the northeast, the tropical plants could scarcely have been taken over by way of Alaska, and megalithic ruins and other traces of primitive cultures similar to those of ancient America, mark a route from Easter Island to Fiji, Sumatra, Madagascar and southern Arabia, whither archeologists now trace the straight-haired men who initiated the agricultural civilizations of the valleys of the Nile and Euphrates.

With the assistance of a kinetic theory of evolution and of pertinent facts and analogies it is thus possible to sketch anthropological evolution without the predication of conditions essentially different from those which exist at the present day. Man is a relatively ancient animal which long since attained a cosmopolitan distribution. Divergent tendencies of variation met, however, with ever-strengthening opposition through the growth of mental powers and social habits, and the segregation of groups comparable to zoological species took place only through geographical isolation. The specific separation of the peoples of the two continents also came to an end with the development in America of the arts of agriculture, navigation and government, which resulted in the conquest and colonization of the islands and shores of the Pacific and Indian Oceans, and the subsequent integration of the superior mixed races and civilizations of these and the adjacent regions.

O. F. COOK.

WASHINGTON, D. C.

*THE NEW LABORATORY AND GREENHOUSE  
FOR PLANT PHYSIOLOGY AT SMITH  
COLLEGE.*

THE remarkable renaissance which botany is experiencing in America, both in investigation and in education, is intimately associated with the development of plant physiology. The reason is plain. The present movement is essentially an exploitation of the new field opened up by our new view of the plant as not primarily a living structure, but a living being. Hence the study of all vital processes becomes of first importance. The new physiological equipment of Smith College, here to be described, is an adaptation to the ever-increasing importance of plant physiology.

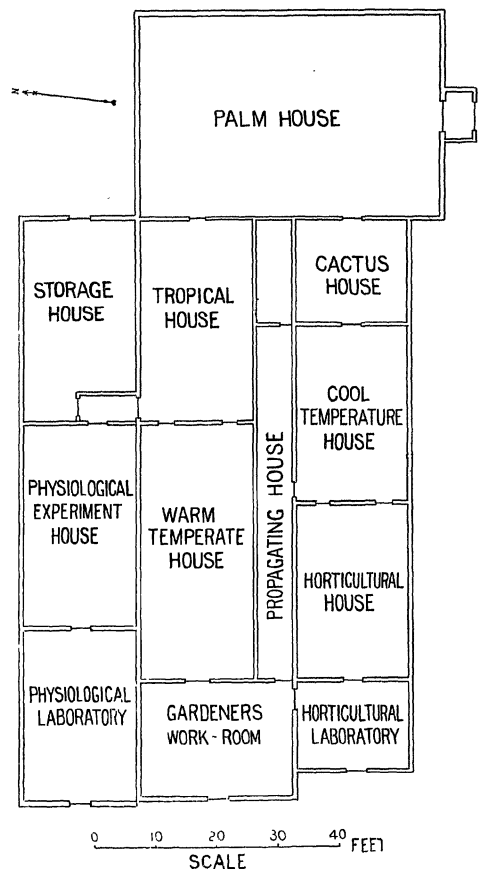


FIG. 1. Ground-Plan of the Lyman Plant House at Smith College.